

U.S. Patent Application Serial No. **10/553,240**
Amendment filed June 29, 2009
Reply to OA dated January 28, 2009

AMENDMENT TO THE DRAWINGS:

The attached sheet of drawings includes changes to the Fig. This sheet, which includes amended Fig., replaces the original sheets including Fig. 1. The label of the sole Figure is corrected from Fig. 1 to "Figure."

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REMARKS

By the present Amendment, independent claim 9 has been amended in order to more particularly point out and distinctly claim the subject matter to which the applicants regard as their invention. More particularly, independent claim 9 has been amended in order to incorporate the subject matter of dependent claims 10, 11 and 13 therein. Additionally, dependent claim 10 has also been amended to further define the amount of organic solvent. Dependent claims 11 and 13 have been canceled.

It is believed that this Amendment is fully responsive to the Office Action dated January 28, 2009, and applicants respectfully submit that no new matter has been added. Claims 9, 10 and 12 are pending in the subject application. Claims 1-8 and 14-31 have been withdrawn. Entry of these amendments is respectfully requested.

In the Action, the drawings were objected to because the sole Figure should be labeled "Figure." A corrected drawing sheet is submitted in response to the Office Action.

In addition, it was requested that the specification be amended, if necessary, with regard to the following:

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(1) Any reference in the specification to "Fig. 1" should be changed to "Figure" to correspond with the sole Figure of the drawings.

(2) The correctness of the reference to the "Carey-Lee" process as set forth on page 10 of the specification should be checked to determine if it should be "Carey-Lea" process. Appropriate correction was required if necessary.

By the present amendments to the specification, "Fig. 1" has been changed to "Figure" and the reference to "Carey-Lee" at page 10 of the specification, an apparent typographical error, has been corrected to "Carey-Lea."

In view of the above amendments, withdrawal of the objections is requested.

Claims 9 and 11-13 were rejected under 35 U.S.C. 102(b) as being anticipated by the patent to Kato et al (US 6,447,909). Although not entirely clear, additionally, claims 9-13 were rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over, the same patent to Kato et al. In making these rejections, it was asserted that Example 1 of the cited Kato et al patent discloses the method as claimed. Further, it was asserted that any differences between the disclosed method and the claimed method are rendered obvious by the known Carey-Lea process. Reconsideration of this rejection in view of the above claim amendments

and the following comments is respectfully requested.

It is submitted that the subject matter of independent claim 9 and the claims dependent thereon are not taught or suggested by the cited patent to Kato et al. In order to further clarify the significant differences between the teachings of the patent to Kato et al., which is directed to a coating liquid for forming a transparent conductive layer in which “the concentration of gold-silver microparticles” in the coating liquid is low, i.e., from about 0.32% to about 0.54%, so as to form a transparent conductive layer, and the subject matter as claimed in independent claim 9 has been amended in the following manner:

(1) the subject matter of claim 13 has been incorporated therein, that is, the fine silver particles in the colloidal dispersion are in a concentration of from 10% to 70%;

(2) the subject matter of claims 10 and claim 11 has been incorporated therein which improves the dispersion stability of the fine silver particles to be in a high concentration; and

(3) the claim additionally recites that the resulting fine silver particle colloidal dispersion does not contain any polymeric dispersing agent.

Before discussing the above rejections in detail, a brief review of the presently claimed invention now may be quite instructive. The presently claimed invention relates to a process for producing a fine silver particle colloidal dispersion in which the fine silver particles in the colloidal dispersion are in a higher concentration than that in the conventional coating liquid for forming a transparent conductive layer. An important object of this invention is to provide a fine silver particle colloidal dispersion capable of forming highly conductive films (but, those conductive films do not require transparency) even when heat-treated at a low temperature after printing or coating as is set forth on page 5, lines 15-19 of the subject specification.

(2) In conventional fine silver particle colloidal dispersions in which the fine silver particles in the colloidal dispersion are in a high concentration as compared to that in the coating liquid for forming a transparent conductive layer, a “polymeric dispersing agent” is included to improve the stability of dispersion of the fine silver particles in a high concentration. Thus, there has been a problem that a conductive silver film to be formed can not easily be made to have a low resistivity if heat-treated at a low temperature after printing or coating as is set forth on page 3, line 17 to page 4, line 7 of the specification. It is therefore necessary to decompose and remove the above-mentioned “polymeric dispersing agent” by high-temperature heat treatment after printing or coating. However, this has caused a problem that the conductive silver film formed by heat treatment at a high temperature becomes impaired in its conductivity as described on page 3, lines 5-16 and page 4, lines 17-22 of the specification.

(3) Consequently, an important object of the present invention is to provide a fine silver particle colloidal dispersion in which the fine silver particles in the colloidal dispersion are set to be in a higher concentration than that in the coating liquid for forming a transparent conductive layer and which does not contain any “polymeric dispersing agent” that would put obstacles to heat treatment at a low temperature.

In order to achieve the above object, the process for producing a fine silver particle colloidal dispersion of a water-organic solvent system according to the presently claimed invention is comprised of: a reaction step of forming an agglomerate of fine silver particles; a filtration step of obtaining a cake of the agglomerate of fine silver particles; a dispersion step of obtaining a first fine silver particle colloidal dispersion of a water system; a concentration and washing step of obtaining a second fine silver particle colloidal dispersion of a water system; and a dilution and viscosity modifying step of adding an organic solvent; wherein the fine silver particle colloidal dispersion after having been wash-treated is controlled to have an electric conductivity of 200 mS/cm or less at the solvent part exclusive of the fine silver particles from the second fine silver particle colloidal dispersion of a water system, and the organic solvent to be used in the dilution and viscosity modifying step comprises dimethyl sulfoxide.

That is, when the washing treatment is performed until the second fine silver particle colloidal dispersion of a water system has an electric conductivity of 200 mS/cm or less at the

solvent part exclusive of the fine silver particles from the second fine silver particle colloidal dispersion of a water system, the concentration of electrolyte in the solvent is lowered, and hence, this colloidal dispersion is improved in its fine silver particle dispersion stability as is disclosed on page 16, lines 6-24 of the specification. In addition, the lowering of the concentration of electrolyte brings an improvement in the dispersion stability of fine silver particles in the fine silver particle colloidal dispersion of a water-organic solvent system in which the organic solvent is mixed with the second fine silver particle dispersion of a water system as described on page 20, line 22 to page 21, line 15 of the specification.

Further, when the organic solvent used in the dilution and viscosity modifying step contains dimethyl sulfoxide, this organic solvent acts on the fine silver particles so as to improve the dispersion stability of the fine silver particle colloidal dispersion. Despite of the use of such an organic solvent, therefore, the fine silver particles are improved in their dispersion stability as is disclosed on page 21, line 16 to page 22, line 19 of the specification.

Thus, although a “polymeric dispersing agent” is not contained which would be an obstacle to low-temperature heat treatment, a fine silver particle colloidal dispersion of a water-organic solvent system can be provided in which the fine silver particles in the colloidal dispersion are in a high concentration.

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With regard to the above-noted effect resulting from using the dimethyl sulfoxide, that is, the effect that the dimethyl sulfoxide acts on the fine silver particles to thereby improve the stability of the fine silver particle colloidal dispersion, this effect has been discovered by the present inventors through their experiments. For details, specific attention is directed to page 21, line 16 to page 24, line 7 of the specification.

It is submitted that the presently claimed process for producing a fine silver particle colloidal dispersion of a water-organic solvent system is not taught or suggested by the cited patent to Kato et al. In this regard, the following distinctions must be emphasized:

(1) The Kato et al patent is drawn to a “coating liquid” used to form a “transparent conductive layer.” Accordingly, when the gold-silver microparticles in the coating liquid are to be in a high concentration, a “transparent conductive layer” is difficult to be formed. To cope with this difficulty, the gold-silver microparticles in the coating liquid for forming a transparent conductive layer are in a concentration of from about 0.32% to about 0.54% . In this regard, specific attention is directed to column 15, lines 4-5; column 16, lines 19-20; column 16, lines 51-52 and the like of the cited patent.

However, this coating liquid for forming a transparent conductive layer can be clearly distinguished from the fine silver particle colloidal dispersion of a water-organic solvent system

according to the present invention in which the fine silver particles are in a high concentration of from 10% by weight to 70% by weight.

In the subject Office Action, it was asserted that “The resulting coating composition of gold coated silver colloids had a particle size of 8.2 nm at a concentration of 68.7% by weight in an aqueous ethanol solution” and hence it was considered that the concentration of gold coated silver colloids in an aqueous ethanol solution was “68.7%.”

However, the cited Kato et al patent states at column 15, lines 6-13 that “As a result of observing this coating liquid for forming a transparent conductive layer under a transmission electron microscope, the mean particle diameter of the noble metal-coated silver microparticles was 8.2 nm. The content ratio of gold in the noble metal-coated silver microparticles was 68.7 wt% from the composition ratio of the above-mentioned coating liquid for forming the above-mentioned transparent conductive layer.”

In contrast to that which was asserted above, the numerical value of “68.7%” indicates the content ratio of gold “in the noble metal-coated silver microparticles,” but not the concentration of gold-coated silver microparticles in the aqueous ethanol solution concerning the coating composition of gold-coated silver colloids.

Therefore, the “coating liquid for forming a transparent conductive layer” of the Kato et al patent can be clearly distinguished from the “fine silver particle colloidal dispersion of a water-organic solvent system” according to the presently claimed invention. Among other things, the concentrations of silver microparticles and the like in the coating liquid (dispersion) are significantly different.

(2) When compared to the “coating liquid for forming a transparent conductive layer” of the Kato et al patent in which the gold-silver microparticles in the coating liquid are in a low concentration (from about 0.32% to about 0.54%) to form a transparent conductive layer, the “fine silver particle colloidal dispersion of a water-organic solvent system” of the present invention, in which the fine silver particles in the colloidal dispersion are in a high concentration of from 10% by weight to 70% by weight, there is a need for some special ingenuity so as to enable the fine silver particles in the colloidal dispersion to be highly dispersible because of a high concentration of fine silver particles, and also some special ingenuity due to the absence of a “polymeric dispersing agent” that would put obstacles to low-temperature heat treatment.

Therefore, the “coating liquid for forming a transparent conductive layer” of the Kato et al patent, that does not need the above ingenuity for enhancing dispersibility, is distinctly different from the “fine silver particle colloidal dispersion of a water-organic solvent system” of the presently claimed invention that requires such ingenuity.

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(3) It was asserted that the patent to Kato et al at column 12, lines 1-10 discloses that ethanol and dimethyl sulfoxide (DMSO) among others as suitable organic solvents, and hence, it would have been obvious to one skilled in the art to employ dimethyl sulfoxide. Additionally, it was asserted that the characteristics of electric conductivity recited in claim 11 would be those inherently provided by the colloidal dispersion of the patent to Kato et al.

As noted above, however, the effect that the dimethyl sulfoxide acts on the fine silver particles to improve the stability of the fine silver particle colloidal dispersion has been discovered only by the experiments of the present applicants. In this respect, any assertion to the contrary appears to be erroneous.

In addition, the fact that the colloidal dispersion of the patent to Kato et al patent cannot provide the electric conductivity recited in claim 11 is evident from the presence of a "polymeric dispersing agent" in the colloidal dispersion as is set forth in column 14, line 61 et seq thereof. As a consequence, any assertion to the contrary also appears to be erroneous.

It is to be emphasized that when use is made of the "fine silver particle colloidal dispersion of a water-organic solvent system" obtained by the process of claim 9, as now amended, it is remarkably effective in obtaining a highly conductive silver film, even if being heat-treated at a low temperature after printing or coating. The reasons for this is that the dispersion stability of fine silver particles is improved in that it requires, among other things, no "polymeric dispersing agent."

Additionally, attention is further directed to Examples 4-7 of the subject specification in which the “fine silver particle colloidal dispersion of a water-organic solvent system” of the presently claimed invention are embodied. In these Examples, the temperature of heat treatment in Example 4 is “at 70°C for 5 minutes in the atmosphere, followed by 150°C for 10 minutes,” the temperature of heat treatment in Example 5 is “in the same manner as in Example 4, ” the temperature of heat treatment in Example 6 is “at 70°C for 5 minutes in the atmosphere, followed by 150°C for 10 minutes,” and the temperature of heat treatment in Example 7 is “at 70°C for 5 minutes in the atmosphere, followed by 150°C for 10 minutes. All such temperatures of heat treatment are lower than “about 200°C” described under the heading “Background Art” in the specification.

In distinct contrast, the patent to Kato et al states at column 15, lines 14-26 that “the coating liquid for forming a transparent conductive layer comprising noble metal-coated silver microparticles was spin coated (130 rpm, 60 seconds) onto a glass substrate (soda lime glass with a thickness of 3 mm) that had been heated to 40°C, and then silica sol liquid was spin coated (150 rpm, 60 seconds) and the product was further cured for 20 minutes at 210°C.” This temperature of heat treatment of 210°C is significantly higher than those in Examples 4-7 of the present specification. In view of data on the Examples according to the patent to Kato et al in which the temperatures of heat treatment exceeded 200°C, there is no disclosure in the patent for the “fine silver particle colloidal dispersion of a water-organic solvent system” as in the present invention.

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(4) As discussed above, the “fine silver particle colloidal dispersion of a water-organic solvent system” according to the process of the presently claimed invention is obtained such that “in the concentration and washing step, the fine silver particle dispersion is controlled to have an electric conductivity of 200 μ S/cm or less at the solvent part exclusive of the fine silver particles from the second fine silver particle colloidal dispersion of a water system” and “the organic solvent to be used in the dilution and viscosity modifying step comprises dimethyl sulfoxide.” Despite the fact that the fine silver particles in the colloidal dispersion are in a high concentration of from 10% by weight to 70% by weight, this colloidal dispersion improves fine silver particle dispersion stability, and hence, requires no “polymeric dispersing agent.” Therefore, the above fine silver particle dispersion of a water-organic solvent system is remarkably effective in obtaining highly conductive films, even if being heat-treated at a low temperature after printing or coating.

Accordingly, the process of the presently claimed invention for producing such a “fine silver particle colloidal dispersion of a water-organic solvent system” patentably distinguishes over the cited Kato et al patent. Therefore, for the reasons stated above, withdrawal of the rejection under 35 U.S.C. § 103(a) and allowance of claims 9, 10 and 12 as amended over the cited Kato et al patent are respectfully requested.

If it is considered that this application is not now in condition for allowance, the Examiner is requested to contact the applicants’ undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

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In the event that this paper is not timely filed, the applicants respectfully petition for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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Enclosures: Replacement Drawing Figure
Petition for Extension of Time